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The role of surgery in management of necrotizing enterocolitis

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ABSTRACT

Objective: : Necrotizing enterocolitis (NEC) has become the most common gastrointestinal emergency among neonates and preterms admitted to the intensive care units.
The aim of this study is to evaluate the surgical management of NEC as well as their outcome.
Patients and methods: : Thirty five cases were included in this prospective study (10 full terms, 15 preterm and 10 infants) with the diagnosis of NEC. The severity of NEC episodes were determined according to Bells classification into group A (stage I 10 cases), Group B (stage II 17 cases) and group C (stage III 8 cases). Full history and clinical examination were taken. Radiological studies (abdominal plain X-ray and ultrasound), blood and stool cultures were done.
Results: : All risk factors such as sepsis, hypoxia, premature rupture of membrane (PROM) and eclampsia were statistically significantly higher among group C than group A. The commonest presenting symptom was abdominal distension followed by vomiting. All positive radiological signs were statistically significantly higher among both groups B&C than group A except for pneumopritonium sign. Medical treatment was started and complete clinical improvement was achieved in all cases of group A and in 2 cases from group B. The remaining 23 cases (15 cases from group B and the 8 cases of group C) failed to respond to the medical treatment and were operated upon. Resection anastomosis was done for 12 cases from group B while resection with stoma formation was done for 3 cases from group B and 8 cases from group C. The over all mortality was 11 cases out of 35 (31.4%). 5 cases from group B and 6 cases from group C.
Conclusions: : Early diagnosis and intensive medical and surgical treatment with laparotomy and resection of the affected bowel were mandatory to minimize both morbidity and mortality from NEC. Primary anastomosis is the procedure of choice as long as the condition of the remaining bowel is satisfactory.

1. Introduction

Necrotizing enterocolitis (NEC) became the most common surgical emergency during the neonatal period. NEC constitutes 1–8% of the admissions in the neonatal intensive care units, with a mortality rate between 20% and 40%.[1–4] Together with the improvement in the neonatal intensive care facilities, the incidence of the disease and its complications are increasing especially in low birth weight (LBW). The disease affects 0.5% of all live births and 3–5% of low birth weight live births.[5–8] The precise aetiology and pathophysiology remain unclear but most likely multifactorial.[2] The triad of intestinal ischaemia, enteral nutrition (metabolic substrate) and pathogenic organisms has been linked to NEC. Although NEC is primarily a disease of preterm infants, it can also be observed in full term neonates and infants especially those with co-existing risk factors like hypoxia, PROM, eclampsia, congenital heart disease, respiratory disease, infections (maternal or fetal), umbilical catheter or exchange transfusion etc.[9,10] The differential diagnosis of NEC includes: specific infections (systemic or intestinal), intestinal obstruction, volvulous and isolated perforation. The current practice emphasizes early recognition and vigorous treatment to minimize the impact of illness on the morbidity and mortality.[2,5]

There are different surgical options available for advanced cases of NEC not responding to medical treatment depending on the extent of the disease, condition of the bowel and the discretion of the surgeon.[9–16]

The aim of this study is to evaluate the surgical management of NEC as well as their outcome regarding the morbidity and mortality.

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Table 1
Risk factors in 35 cases of NEC.

	Group A no 10	Group B no 17	Group C no 8	Total no 35	*P* value A vs C
Sepsis	2/10 (20%)	8/17 (47%)	6/8 (75%)	16/35 (45.7%)	0.01[a]
Hypoxia	1/10 (10%)	5/17 (29.4%)	5/8 (62.5%)	11/35 (31.4%)	0.002[a]
PROM	2/10 (20%)	7/17 (41.1%)	6/8 (75%)	15/35 (42.8%)	0.002[a]
Eclampsia	0/10 (0%)	3/17 (17.6%)	4/8 (50%)	7/35 (20%)	0.006[a]

(p) < 0.05.
[a] Statistically significant result. There was no statistical significant difference between either groups A&B or B&C.

Table 2
The different clinical features in 35 cases of NEC.

	Group A no 10 (%)	Group B no17 (%)	Group C no 8 (%)	Total no 35	*P* value A vs C
Poor feeding	5 (50%)	12 (70.5%)	8 (100%)	25(71.4%)	0.001[a]
Vomiting.	6 (60%)	14 (82.3%)	8 (100%)	28 (80%)	0.02[a]
Abdominal distension	7 (70%)	15 (88.2%)	8 (100%)	30 (85.7%)	0.04[a]
Diarrhoea	1 (10%)	4 (23.5%)	3 (37.5%)	8 (22.8%)	0.002[a]
Constipation	2 (20%)	7 (41.1%)	6 (75%)	15 (42.8%)	0.01[a]
Jaundice	1 (10%)	4 (23.5%)	2 (25%)	7 (20%)	0.02[a]
Pneumonia	2 (20%)	7 (41.1%)	6 (75%)	15 (42.8%)	0.002[a]
Lethargy	5 (50%)	13 (76.4%)	8 (100%)	26 (74.2%)	0.001[a]
GIT bleeding	2 (20%)	10 (58.8%)	7 (87.5%)	19 (54.2%)	0.001[a]

(p) < 0.05.
[a] Statistically significant result. There was no statistical significant difference between either groups A&B or B&C.

2. Patients and methods

Thirty five patients (22 males and 13 females) with the diagnosis of NEC were included in this prospective cohort study during the period May 2006 till November 2008. They were 10 full term neonates (mean gestational age 38.6 wk ± 1.07, mean birth weight 3340 g ± 0.22), 15 preterm neonates (mean gestational age 31.6 wk ± 1.39, mean birth weight 2126 g ± 0.16) and 10 infants <6 months of age (mean age 3.7 months ± 1.33, mean weight 4540 g ± 0.90). Patients were diagnosed as NEC according to (clinical manifestations and vital signs as well as positive radiological signs).[3] The followings were done to all patients included in this study, complete history including: Obstetric history (pre-eclampsia/eclampsia, infections, PROM, maternal drug intake and birth anoxia), history of hospital admission, duration of hospital stay, umbilical catheterization, exchange transfusion and type of feeding. Thorough clinical examination and bacteriological studies including blood and stool cultures for both aerobic and anaerobic bacteria were also done. Patients with specific infections (systemic or intestinal) and intestinal obstruction (volvulous or isolated perforation) were excluded from this study.

The severity of NEC episodes on presentation were determined using Bells classification.[3]

Ten cases met the criteria of stage I (suspected) classified as group A (2 full term and 8 infants) with mean weight 4.500 g ± 1.2.

Seventeen cases met the criteria of stage II (definite) classified as group B (7 preterm, 8 full term and 2 infants) with mean weight 3.800 g ± 1.9.

Eight cases met the criteria of stage III (advanced) classified as group C (all were preterm) with mean weight 2.150 ± 0.25.

The duration between start of patient illness and presentation with start of medical treatment ranged from 24 h to 5 days.

Medical treatment in the form of GIT rest by nasogastric suction, IV fluids, total parenteral nutrition (TPN), broad spectrum IV antibiotics, correction of electrolyte disturbances and acid base balance. Fresh frozen plasma and/or blood transfusions were given when needed.

Signs of improvement under medical treatment included: decrease of abdominal distension and tenderness, remission of abdominal wall cellulites in addition to stability of the vital signs. The indications for laparotomy were the clinical deterioration despite of intensive medical care, evidence of intestinal obstruction and/or perforation and severe gastrointestinal bleeding. The duration between diagnosis and surgical intervention ranged from 6 h to 48 h according to the patient's condition.

3. Statistical analysis

Statistical analysis of data was carried out by using hypothesis test for two proportions from independent groups (Z test). (P) Value less than 0.05 was considered significant.

4. Results

Table 1 shows the risk factors encountered. There was statistical significant difference between group A and group C in all risk factors. Table 2 shows the frequency of different clinical features among the thirty five cases. The commonest symptoms were abdominal distension followed by vomiting and lethargy. There was statistical significant difference between group A and group C in all parameters. Table 3 shows the positive radiological signs in the thirty five cases. The positive radiological signs were statistically significantly higher in both groups B&C than group A except for pneumoperitonium sign. Table 4 shows both blood and stool cultures in the thirty five cases; the most common organism encountered in blood culture was staphylococcus Aureus and mixed in group A, *E. coli* and mixed in group B, and mixed organisms in group C. The most common organisms in stool culture were *Staphylococcus aureus* and mixed bacterial infection in group A and mixed organisms in both groups B&C.

Medical treatment was successful in all cases of group A and 2 cases of group B. Surgical intervention was done for 15 cases of group B and all cases of group C.

Operative details: On exploration there were focal or multiple gangrenous and necrotic patches with variable lengths (ranged from 2 cm to 15 cm) in the terminal ileum in nine patients and in ascending and transverse colon in fourteen cases (Figs. 1 and 2).

Table 3
The radiological findings in 35 cases of NEC.

+ve signs	Group A no 10	Group B no17	Group C no 8	Total no 35	*P* value A vs B	*P* value A vs C
Intestinal distension	3/10 (30%)	15/17 (88.2%)	8/8 (100%)	26/35 (74.2%)	0.001[a]	0.001[a]
Oedema of intestinal wall	0/10 (0%)	7/17 (41.1%)	6/8 (75%)	13/35 (37.1%)	0.01[a]	0.001[a]
Peritoneal fluid	0/10 (0%)	6/17 (35.2%)	5/8 (62.5%)	11/35 (31.4%)	0.02[a]	0.002[a]
Pneumatosis intestinalis	0/10 (0%)	4/17 (23.5%)	3/8 (37.5%)	7/35 (20%)	0.05[a]	0.02[a]
Pneumoperitonium	0/10 (0%)	0/17 (0%)	5/8 (62.5%)	5/35 (14.2%)	N/S	0.002[a]

(p) < 0.05.
N/S = not significant. No statistical significant difference between groups B&C except for pneumoperitonium sign. (p) = 0.002 No statistical significant difference between groups A&B in pneumopritonium sign.
[a] Statistically significant result.

Table 4
The results of blood and Stool cultures in 35 cases of NEC. Group A (10)Group B (17) Group C (8).

Organisms	Blood	Stool	Blood	Stool	Blood	Stool
Staph.	4 (40%)	4 (40%)	4 (23.5%)	5 (29.4%)	2 (25%)	2 (25%)
E coli	2 (20%)	3 (30%)	6 (35.2%)	6 (35.2%)	3 (37.5%)	4 (50%)
K. pneumonae	0%	0%	2 (11.7%)	0%	0%	0%
Pseudomonus	0%	1 (10%)	2 (11.7%)	2 (11.7%)	1 (12.5%)	1 (12.5%)
Mixed	4 (40%)	4 (40%)	10 (58.8%)	11 (64.7%)	6 (75%)	7 (87.5%)
−ve culture	4 (40%)	2 (20%)	3 (17.6%)	4 (23.5%)	2 (25%)	1 (12.5%)

Primary resection of the affected part of the bowel with primary anastomosis (RA) was done in 12 cases of group B. Resection and proximal enterostomy with distal mucous fistula (RS) was performed in 3 cases of group B and all cases of group C because of doubtful viability of the remaining bowel (Table 5). The start of oral feeding ranged from 3 to 5 days using low birth weight formula for premature babies and regular formula in full terms. Stoma closure was done two to three months later for the survived cases (two cases). The postoperative complications occurred in 6 cases out of 23 patients undergoing surgery (26%); 4 cases had wound infection (1 from group B and 3 from group C) improved conservatively except one case from group C died later from sepsis and DIC. One case from group C had burst abdomen, secondary closure was done but he died later from multiple organ failure. One case from group B had minor anastomotic leak managed conservatively and improved (Table 5). The over all mortality was encountered in 11 patients out of 35 cases (31.4%) 5 from group B and 6 cases from group C. Both morbidity and mortality were evident among the group of patients underwent RS than the patients hadRA (4 vs 2 morbidity) and (9 vs 2 mortality). The mortality in this study occurred during first postoperative week and was attributed to septicaemia and DIC in 8 patients and to multiple organ failure in 3 (Table 6). Follow up period ranged from 2 to 6 months for the survived cases after recovery during which no evidence of short bowel, stricture or recurrent attacks of NEC.

5. Discussion

NEC usually starts during the first 2 weeks of life, but may be as late as 2 months of age in LBW. The diagnosis of NEC depends mainly on the clinical features and the radiological findings.[4] Abdominal distension and vomiting were the commonest and early symptoms to be observed in 30 and 28 cases (85.7% and 80%) respectively followed by lethargy in 26 cases (74.2%) and then poor feeding in 25 cases (71.4%). This is in agreement with the recent reported literature.[5] Intestinal pneumatosis is considered pathognomonic radiological sign of NEC while pneumoperitonium is accepted as an indication for surgical exploration. On the other hand portal venous gas sign not only correlates with the disease severity but also with high mortality rates.[2] In this study intestinal pneumatosis was encountered in 7 cases out of 35(20%), pneumoperitonium in 5 cases (14.2%) and no single case with portal venous gas. Regarding blood culture it was positive in 26 cases (74.2%), where stool culture was positive in 28 cases (80%) mixed bacterial infection was the commonest organisms isolated in both blood and stool.

Fig. 1. Shows multiple gangrenous segments of the small intestine.

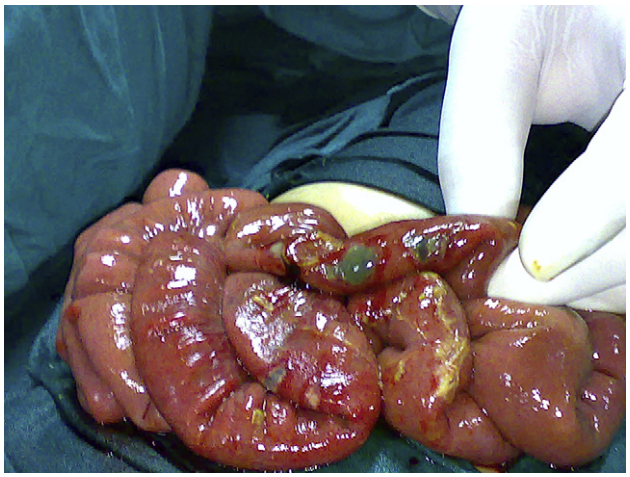

Fig. 2. Multiple necrotic small intestinal segments.

In this study early diagnosis and intensive medical treatment resulted in complete cure of all cases from group A and in two cases from group B. However 23 cases (65.7%) failed this regimen and required operative intervention because of late presentation (two to five days from the onset of the disease) and advancement of the disease. Pierro and Hall[1] reported that up to 50% of neonates with NEC required operative intervention. Butter et al.[5] reported an increase in the operative intervention rate from 46% between 1990 and 1994 to 69% between 1995 and 1999.

The indications for surgery in this study were continuous clinical deterioration despite of intensive medical treatment and signs of intestinal perforation and or obstruction or sever gastrointestinal bleeding.

The surgical management for advanced NEC are either: primary peritoneal drainage which may be followed by laparotomy or laparotomy from the start.[11–14] Laparotomy may end with resection with primary anastomosis (RA) or resection with proximal enterostomy and distal mucous fistula (RS). However proximal jejunostomy without resection "clip and drop" technique may be used.[1,4] Resection of the affected part with primary anastomosis (RA) or resections with stoma (RS) were the procedures done in this study. RS was done in 11 cases because of doubtful viability and oedematous inflamed bowel. RA was done in 12 cases. Both morbidity and mortality were common among patients underwent RS than those underwent RA. In this study the postoperative complications were encountered in 6 patients out of 23 patients undergoing laparotomy. Comberos,[11] reported postoperative complications in 11 of 35 patients undergoing laparotomy. Although their series focused only on low birth weight neonates, this study also included twenty five neonates fifteen of them were prematures. The over all mortality rate in this study was 31.4%, others reported slightly lower mortality rates (26%).[11] The lower mortality rates encountered by those authors could be attributed to early diagnosis, intensive medical and surgical treatment as well as the improvement in neonatal intensive care facilities. The higher mortality rate encountered in this study especially among group C related to the delayed presentation and advancement of the disease.

Table 5
The different surgical techniques and postoperative complications in 23 cases of NEC.

	Surgical techniques		Morbidity		
	Primary resection anastomosis	Resection + proximal enterostomy & distal mucous fistula	Wound sepsis	Burst abdomen	Minor anastomotic leak
Group B no 15	12/15 (80%)	3/15 (20%)	1/15 (6.6%)	0/15 (0%)	1/15 (6.6%)
Group C no 8	0/8 (0%)	8/8 (100%)	3/8 (37.5%)	1/8 (12.5%)	0/8 (0%)
Total no 23	12/23 (52.1%)	11/23 (47.8%)	4/23 (17.4%)	1/23 (4.3%)	1/23 (4.3%)

N.B. Wound sepsis was statistically significantly higher in group C than group B ($P = 0.03$).

Table 6
The over all mortality among 35 cases of NEC.

Mortality	Group B 17	Group C 8	Total 35
Sepsis & DIC	5/17 (29.4%)	3/8 (37.5%)	8/35 (22.8%)
Multiple organ failure		3/8 (37.5%)	3/35 (8. 6%)

N.B No statistical significant difference between group B & C in the over all mortality rate.

Therefore the surgical intervention must accomplish in the proper time before deterioration of the patient's condition especially among patients having definite or advanced NEC episodes (stage II or III). Although the radiological signs mentioned in Bell's classification is of great predictive value, negative radiological signs should be interpreted with extreme caution and the decision not to intervene surgically should not based only on these negative signs. The clinical indications for surgical intervention are still of great importance in making management decisions. Primary laparotomy with resection of the affected part of the bowel provides safe and definitive management of NEC because it verifies the nature and extent of the disease, removes the necrotic bowel and minimizes further complications. This is followed by either RA or RS according to the local pathology and the general condition of the patients. However stoma should be avoided as possible to save the patient the stoma related complications (wound infection, dehiscence, fluid and electrolyte losses).

6. Conclusions and recommendations

High index of suspicion is required for early diagnosis of neonates and infants who are at high risk of NEC. Surgical treatment should be done in the proper time before deterioration of the general condition of the patients and should be reserved for those patients who fail to respond to medical treatment, or in whom complications supervene especially in definite and advanced NEC. Resection of the affected bowel with primary anastomosis is mandatory to minimize both the morbidity and mortality.

Conflict of interest statement
None to declare.

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Ethical approval
None declared.

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